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Detection Limits of Optical Gas Imaging for Natural Gas Leak Detection in Realistic Controlled Conditions

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Overview of Testing Protocol

Goal

Evaluate the efficacy of OGI surveys at gas production sites and explore the influence of:

- Camera sensitivity
- Meteorological conditions
- Leak size/type
- Human factors

Method

- Blind surveys
- Controlled, but realistic outdoor environment
- Each team = camera operator + optional assistant
- Teams bring own camera & protocol
- Multiple test days per operator
- Any safe weather conditions



Quick Definitions

- OGI = Optical Gas Imaging
 - IR-spectrum cameras tuned to mid-IR where methane is visible
- LDAR = Leak Detection and Repair
 - Umbrella term for operators' leak detection methods
- Compliance (teams)
 - Regulatory teams that do spot checks on emissions from O&G facilities
- Contractor (teams)
 - Service providers who perform leak detection services ... typically LDAR without doing repair
- "Pad-level Test"
 - A single test configuration on one test pad with zero or more leaks

Team Survey Form

Operator Info

Operator Information	
Organization	
Address	
Phone	
Email	
Operator's Name	
What is your affiliation (EPA, State – which, Operator, or contractor)	
Do you have a written procedure for OGI camera operation?	
Can you provide this procedure to METEC?	
How many OGI surveys have you conducted?	
At how many oil & gas well pad facilities have you conducted OGI surveys? (rough estimate)	
Describe the training or certification you received from the manufacturer of your OGI camera?	
Under what weather conditions would you typically stop conducting an OGI survey?	
When conducting OGI surveys at well pads, do you typically ascend to the top of the catwalk by the storage tanks?	
What is your initial site survey strategy – high or regular sensitivity mode?	
What is your usual observation distance (feet) to confirm a leak?	
How long do you usually measure a leak – time sustain (min.)?	

Camera Info

OGI Camera Information	
Manufacturer	
Model Number	
Year Manufactured	
Serial No.	
Most Recent Calibration Date	
Camera Optics (long/short range)	
Software Release/Revision Date	
Camera Spectral Window (μ)	



Test Methods

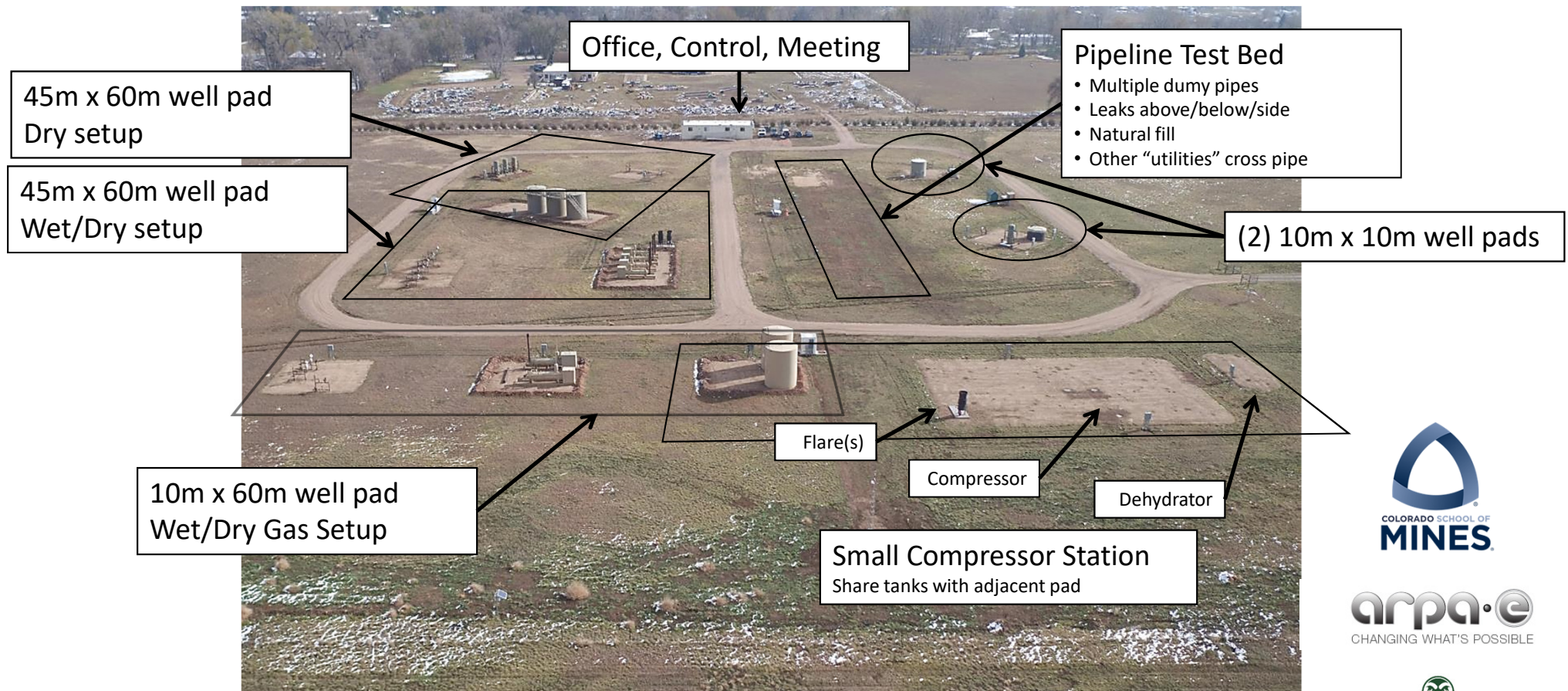


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The **MeTEC_{H4}** Facility



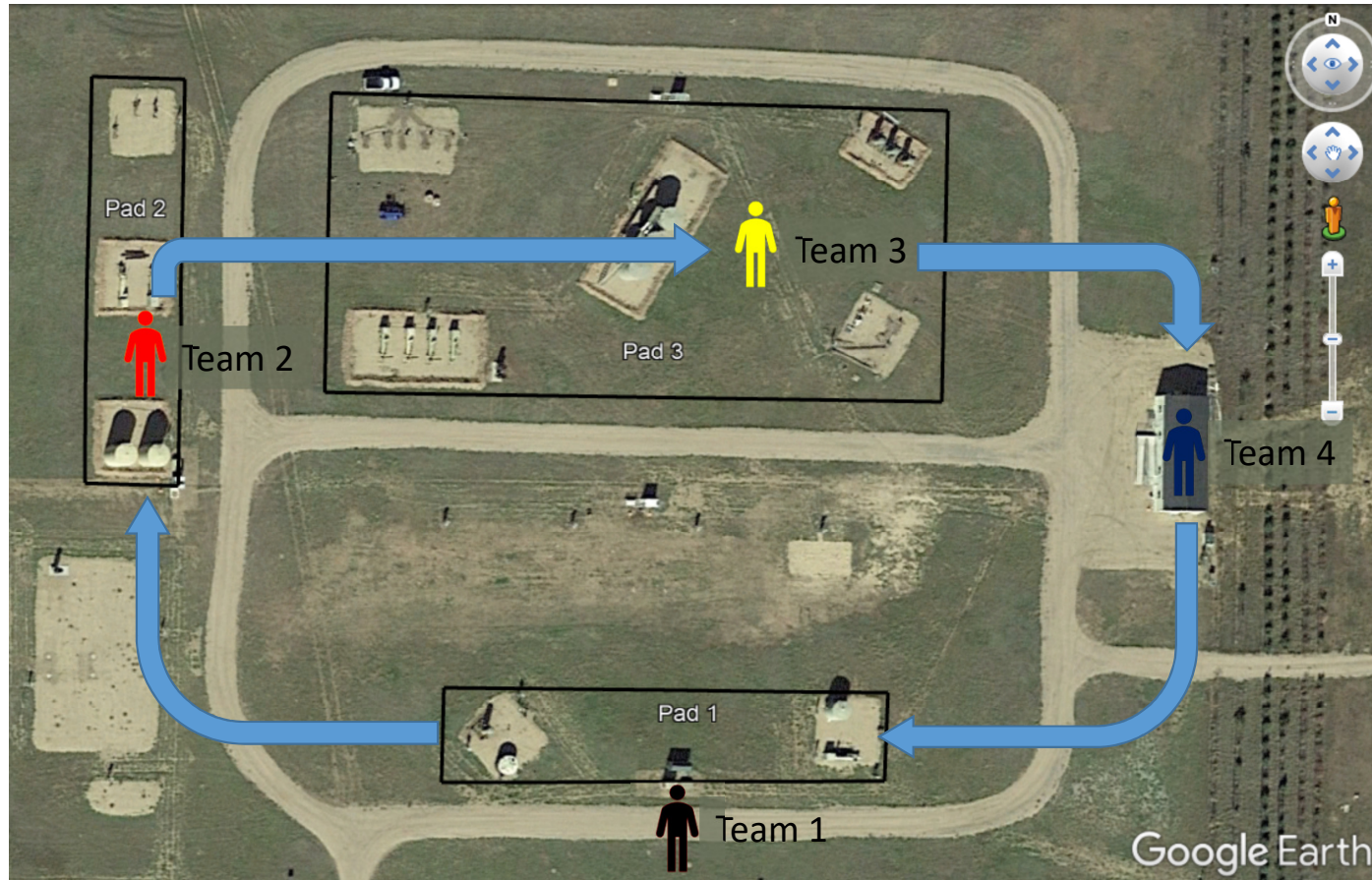
METEC In One Slide...



Pad Layout For Testing



Measurement Flow / Multiple Teams



Operator Field Detection Log Sheet

To be completed during surveys:

At each well pad and for each emission detected, enter all the requested information in the table:

Well Pad #1

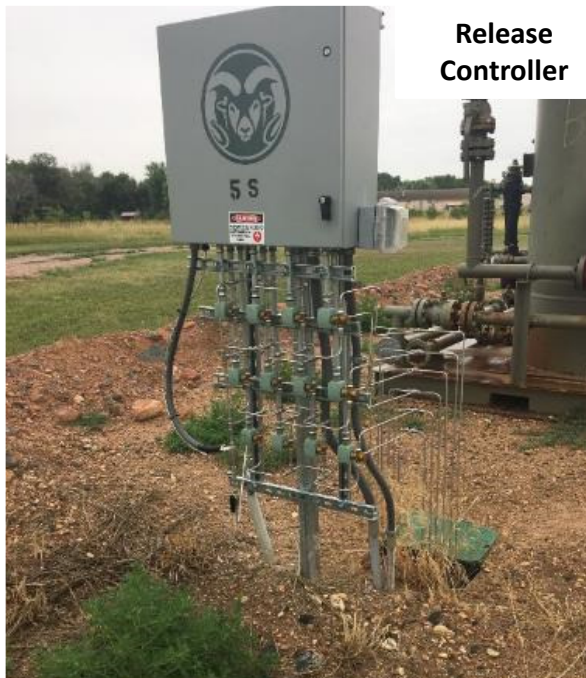
Start time surveying Well Pad #1: _____

Measurement/Observation	Units	1st Detected Emission	2nd Detected Emission	3rd Detected Emission	4th Detected Emission	5th Detected Emission
Start time, detecting an emission	hh:mm MST					
Initial scan distance	Feet (estimated)					
Emission detection distance	Feet (estimated)					
Confirmation distance	Feet (estimated)					
Video file distance	Feet (estimated)					
Emission Location (e.g., flange, PC valve)	Describe site of emission					
Emission constancy	Continuous/Intermittent					
Meteorological conditions	Text Observations					
End time for detecting/locating an emission	hh:mm MST					
Notes/comments	Text					

End time for surveying Well Pad #1: _____

Gas Release Equipment

Gas release controllers and equipment



Release
Controller



Tubing for gas releases is well hidden on test pads "2" and "3" than on test pad "1"



Other Testing Notes

- **No equipment is heated**
 - In field conditions, separators may be heated for process reasons
 - Change background conditions for OGI
- **Gas is released at near-atmospheric pressure** at low velocity
 - In some field conditions, leaking gas may be emitted at high pressure and velocity, forming a small jet near the point of the leak
- **Most tests were completed using industrial methane** – no odor
 - Field gas typically has heavier hydrocarbons that are also visible on OGI
 - Field gas may have some odor
- **In test conditions, operators may operate at heightened sensitivity**



Who & What Was Tested



Data Presented Today

- Updated from Abstract:
 - Additional test days
 - Some additional analysis



Who Tested: Two Groups

Professional OGI Teams

- LDAR contractors
- LDAR teams from operators
- Compliance teams from federal, state and county

1297 non-zero pad/test points

74 zero-emission test points

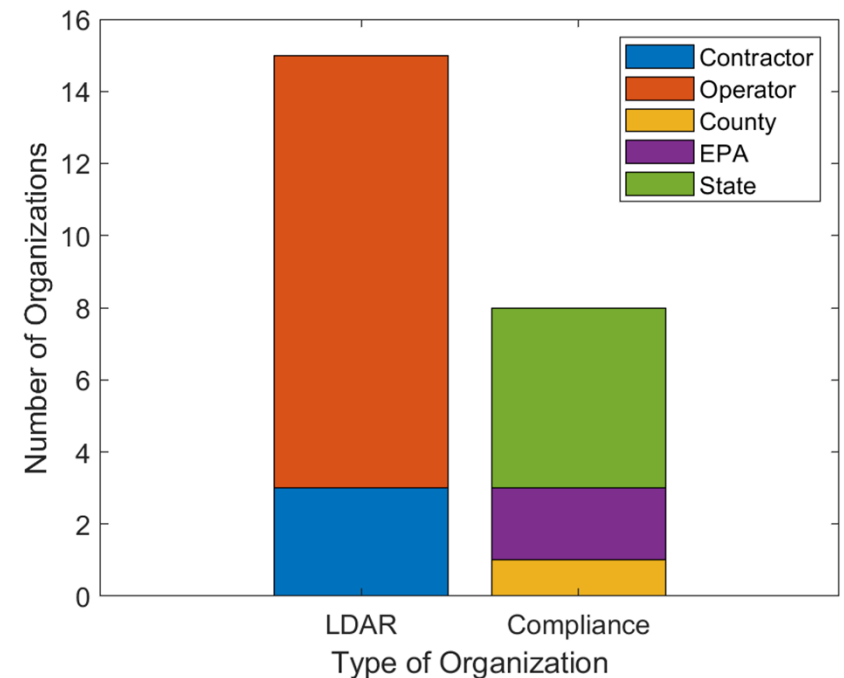
Amateur / Other OGI Teams

- Amateur operators (e.g. university)
- Manufacturers developing cameras

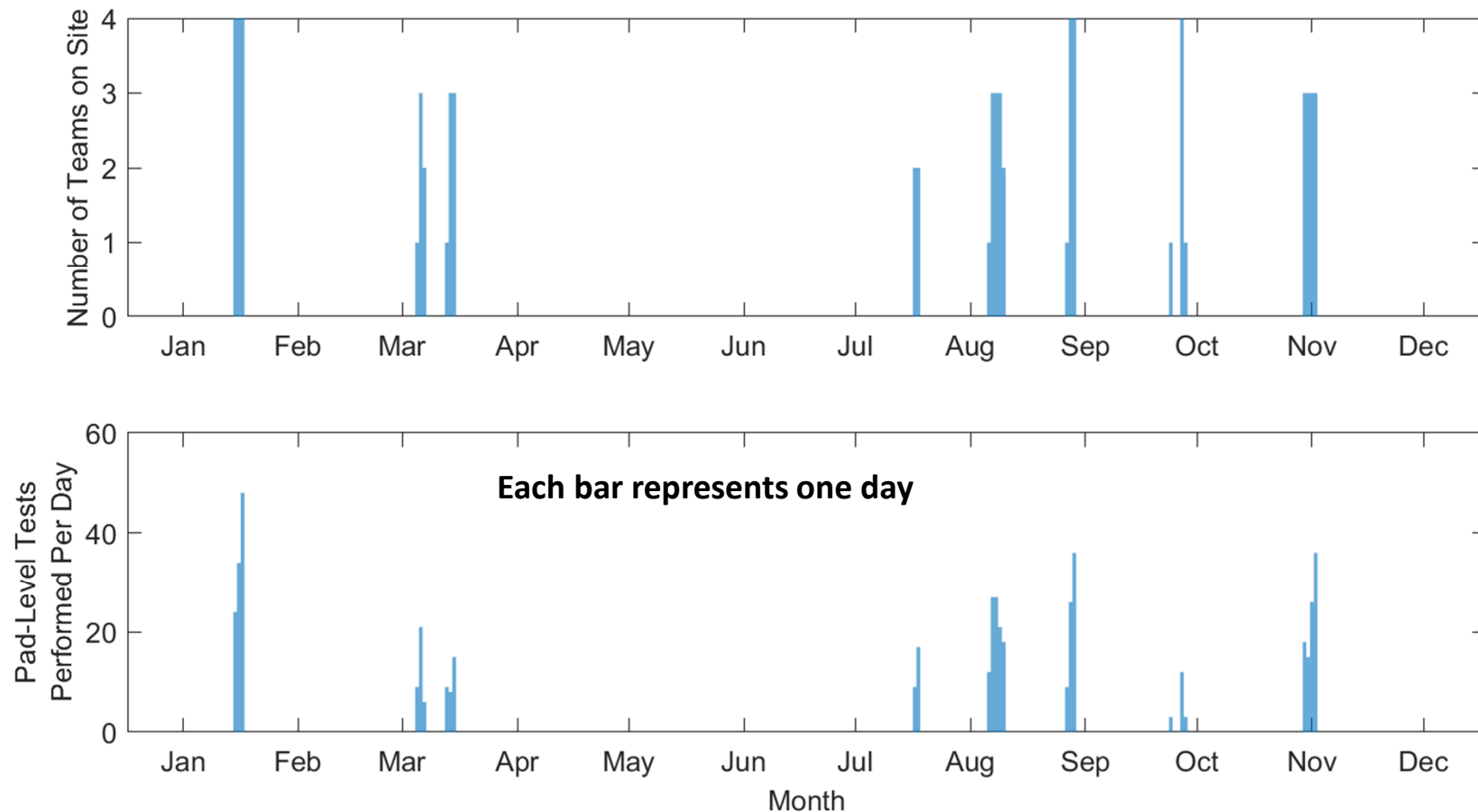
All analysis in this presentation uses data from professional team data only

Teams

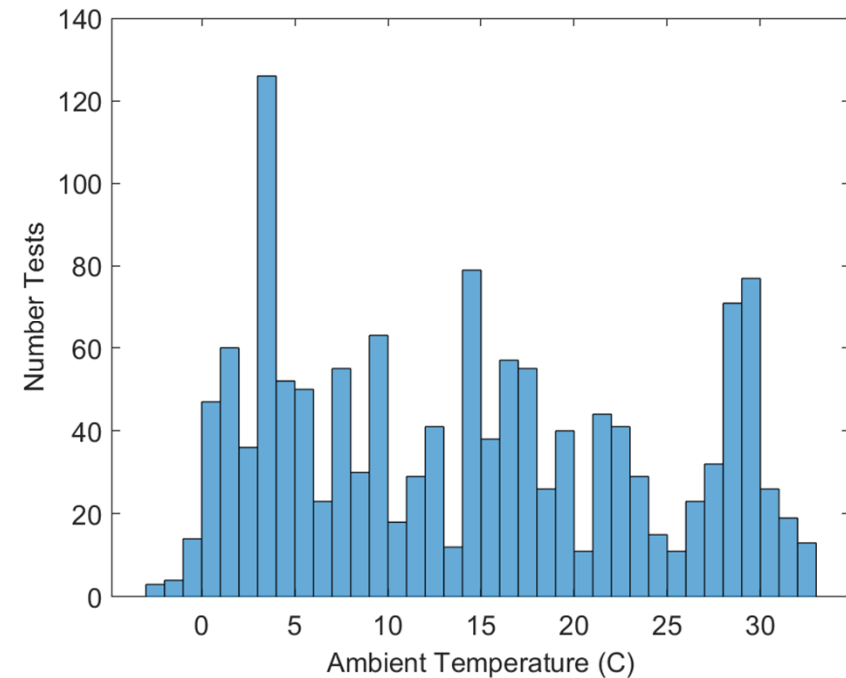
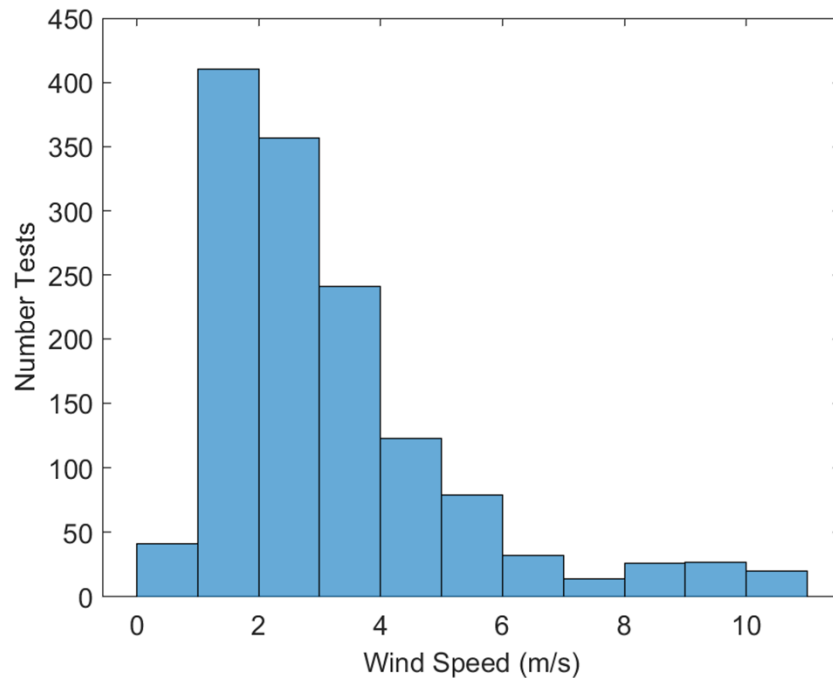
- 38 individual camera operators
 - Occasionally with “note keeper” assistant
- 23 unique organizations
 - 1-3 camera operators per organization
- All but one organization volunteered to participate



Testing: How Much & When



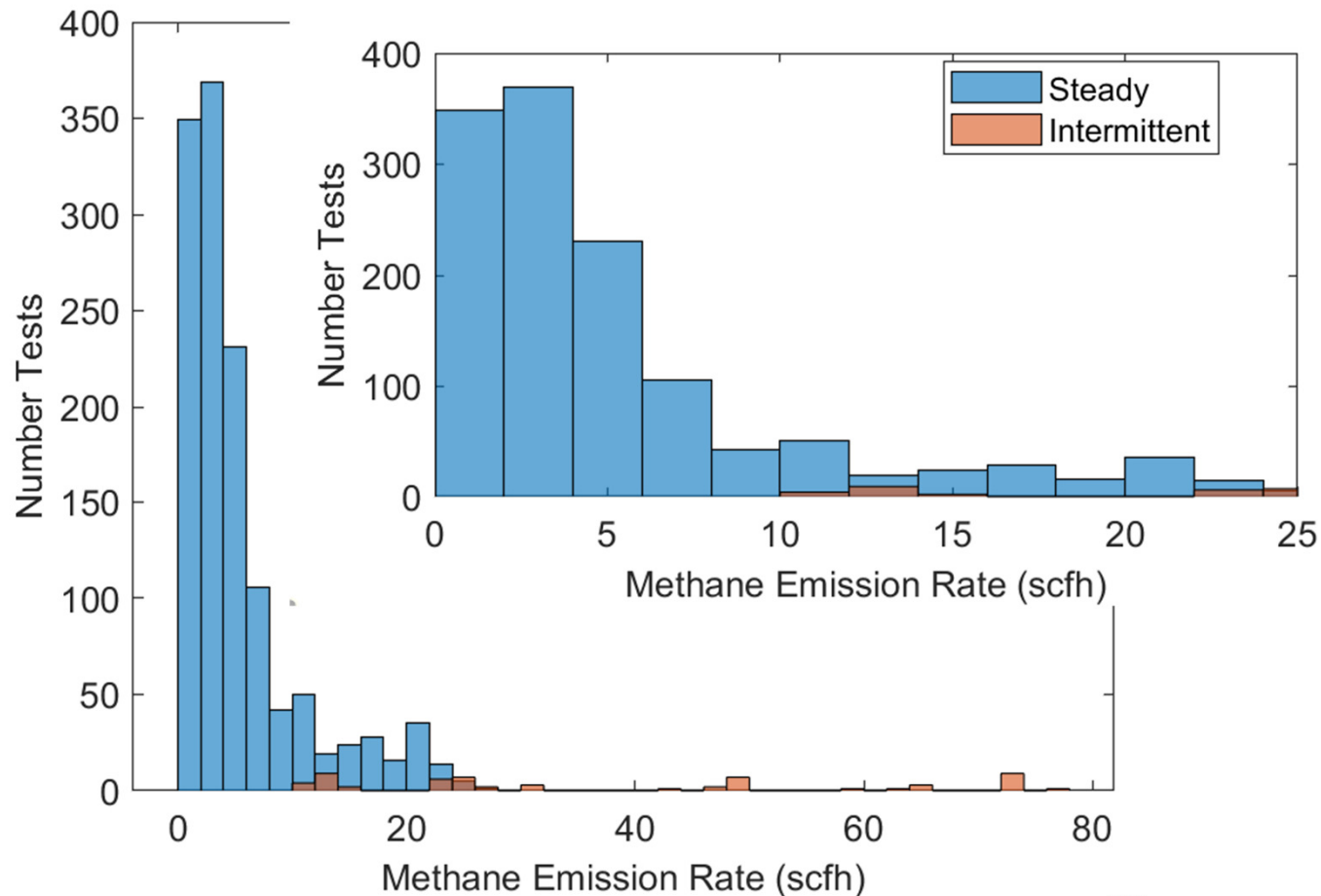
Environmental Conditions



- Broad range of temperatures ... but limited testing with winds above 4 m/s

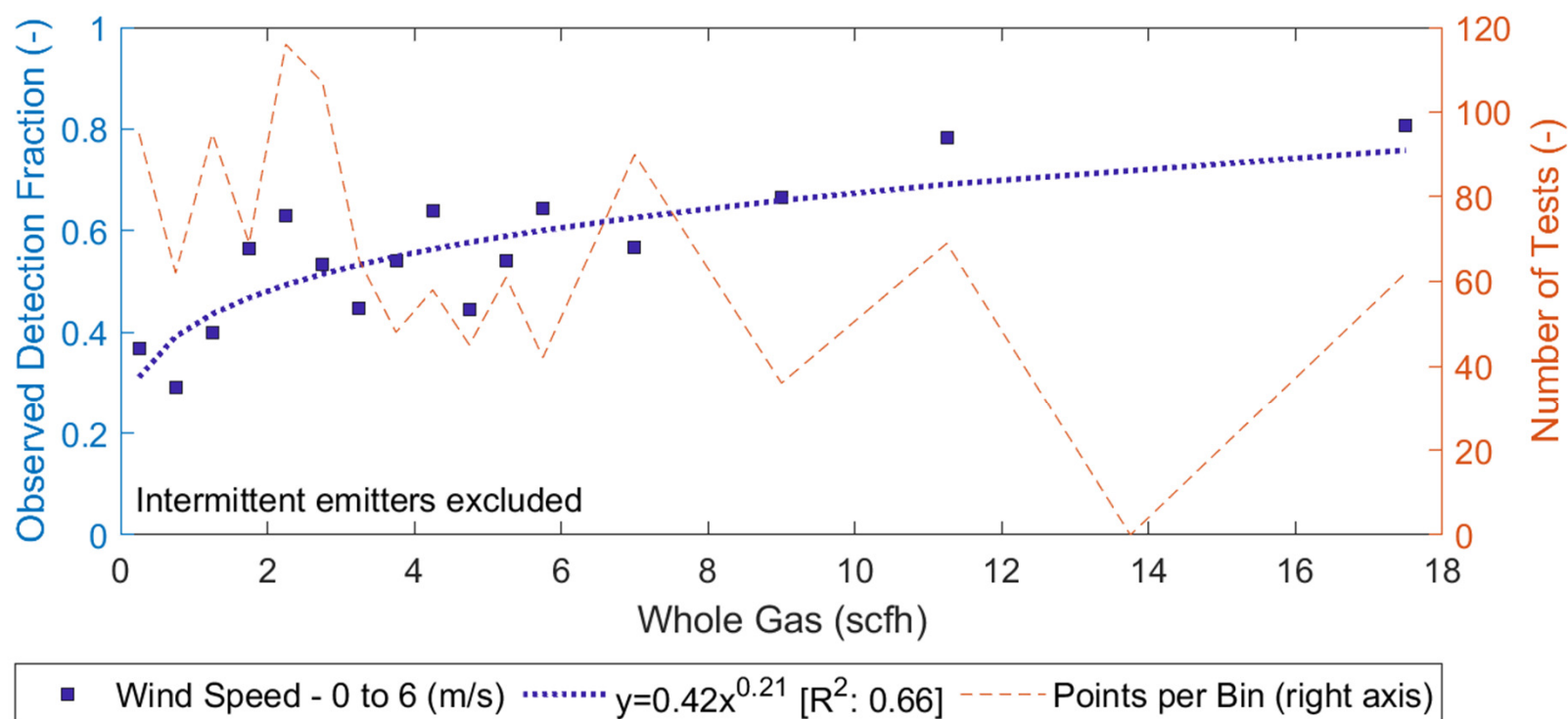
Emission Rate

- Tests designed to focus on lower flow ranges
- Intermittent emitters proved difficult to analyze post-campaign



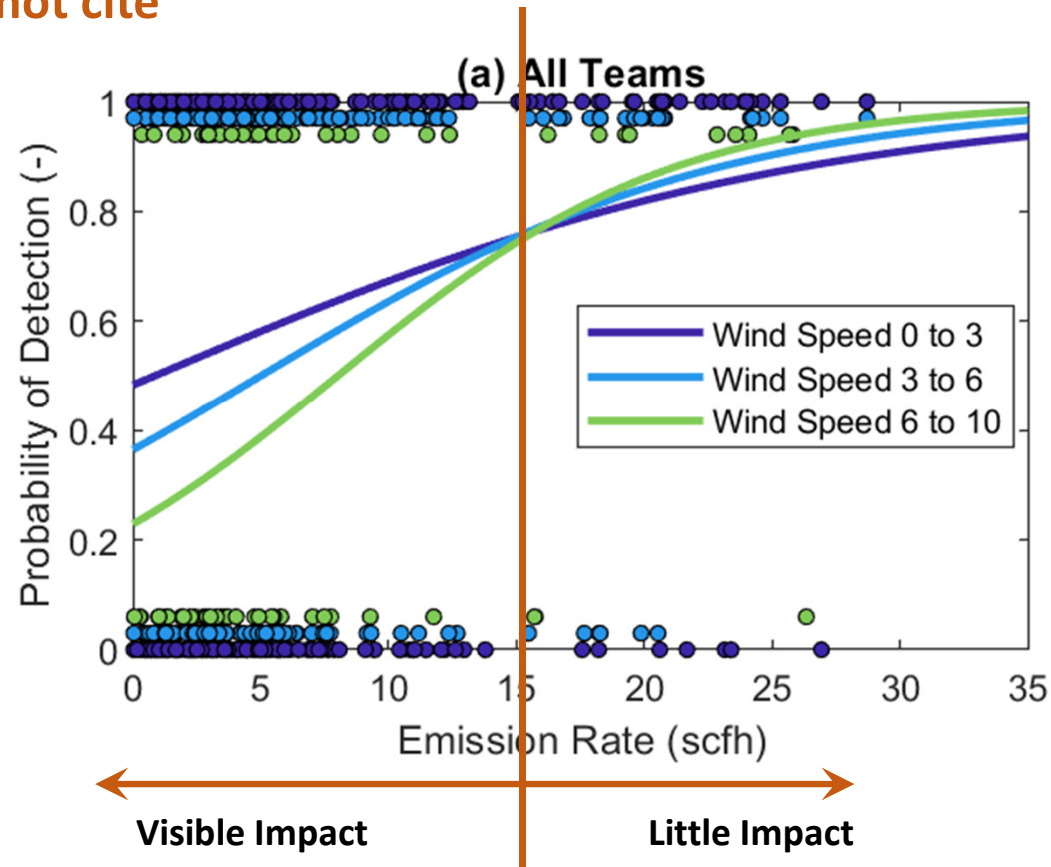
Overall Detection Performance

Preliminary: Do not cite



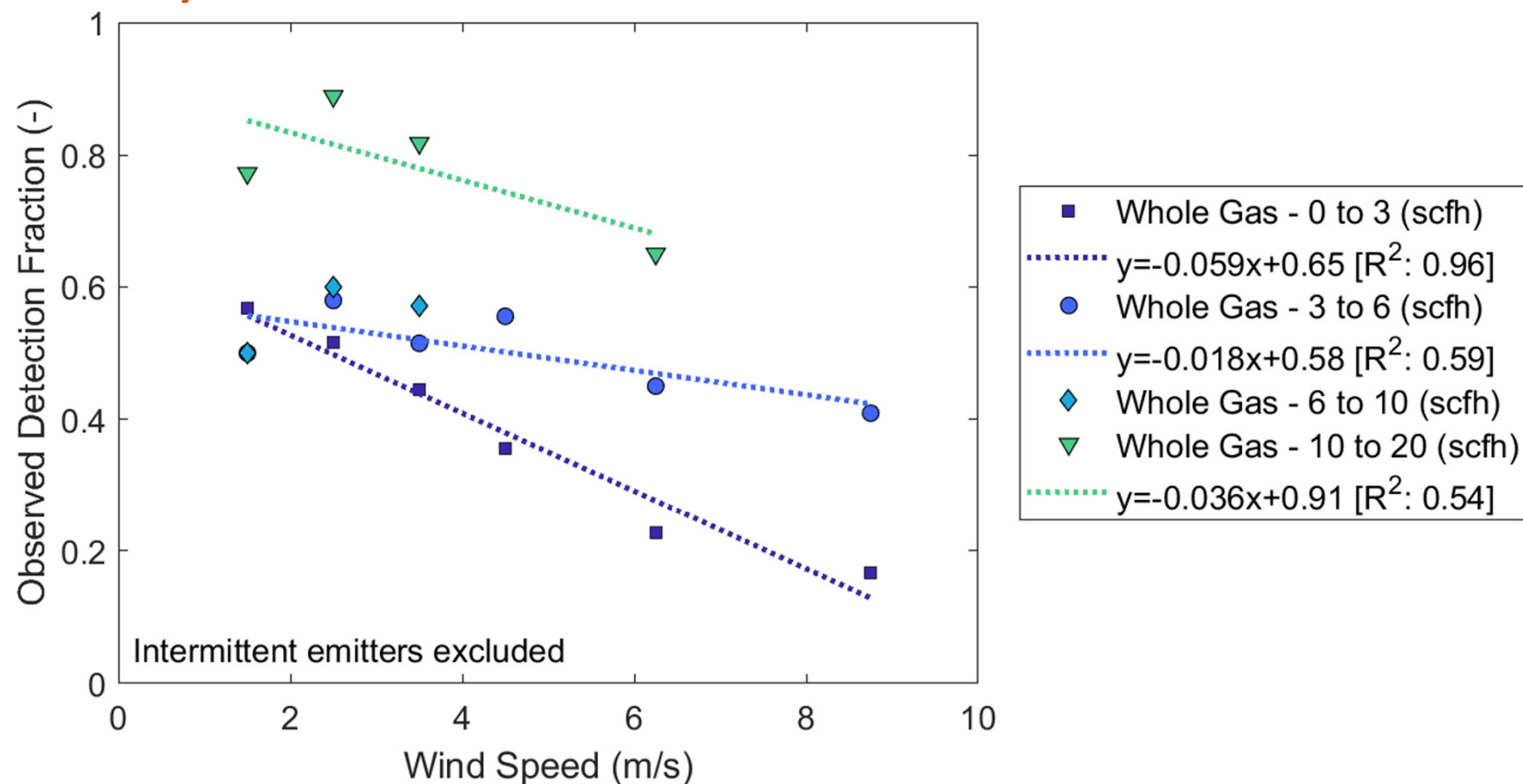
Wind Speed Impact

Preliminary: Do not cite



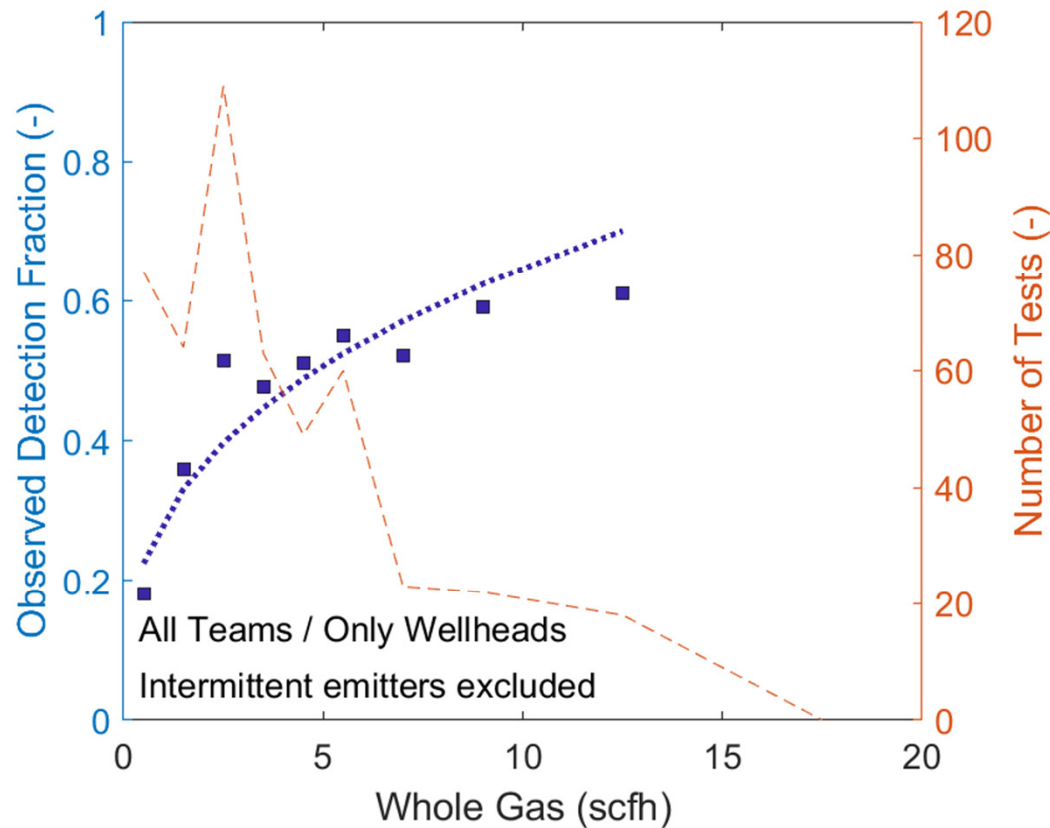
Detection with Wind Speed

Preliminary: Do not cite



Detection On Wellheads

Preliminary: Do not cite

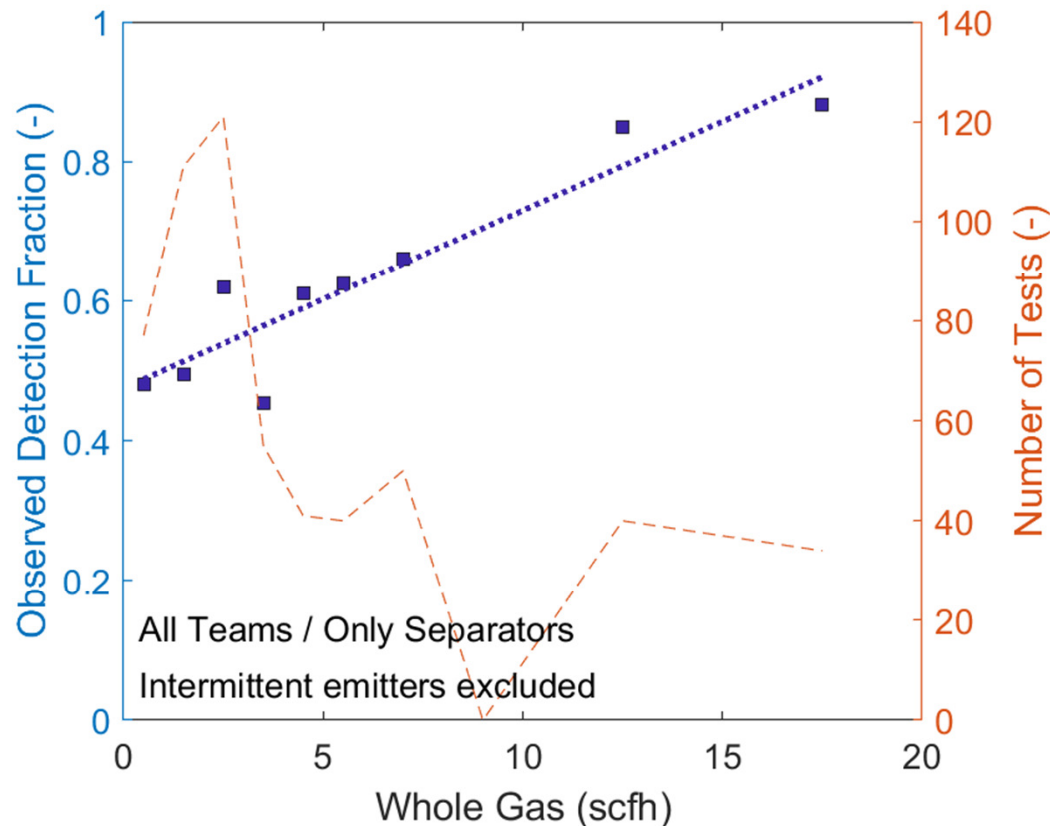


Wellheads

- Lowest complexity equipment
- Least sheltered from wind
- No large surfaces for background

Detection on Separators

Preliminary: Do not cite

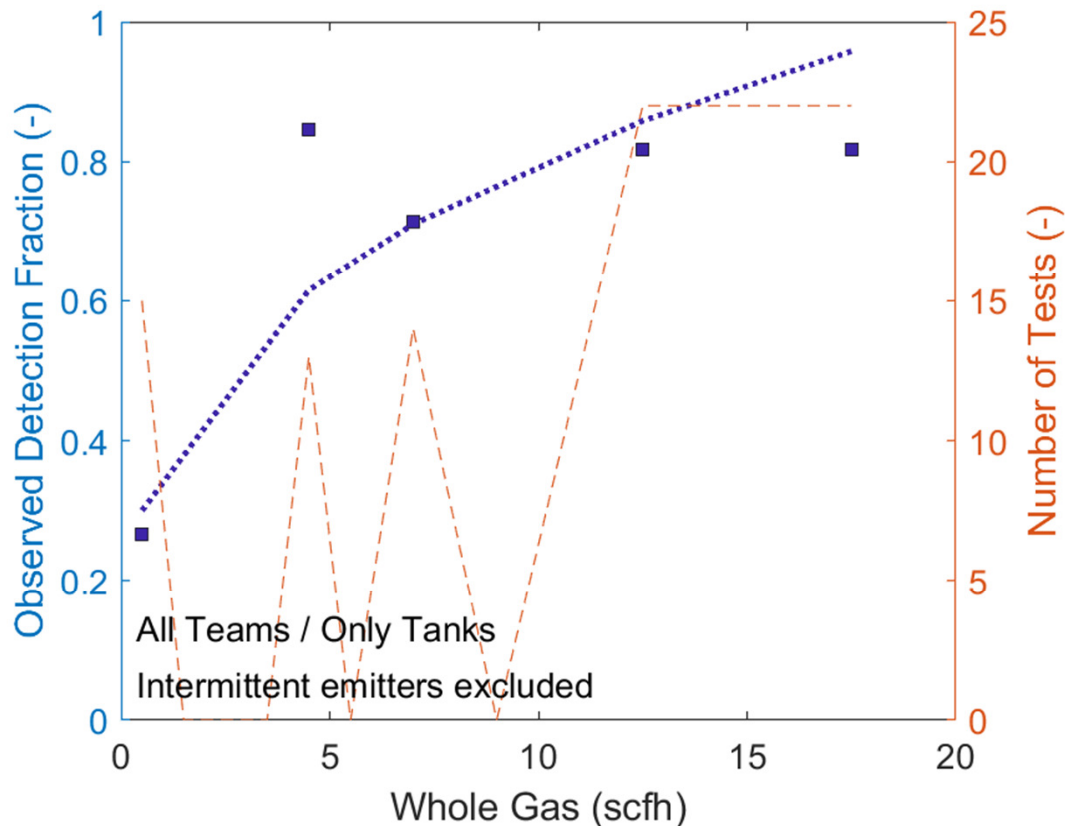


Separators

- Highest complexity equipment
- Larger background surfaces
- Inside components (in doghouse)

Detection on Tanks

Preliminary: Do not cite



Tanks

- Lowest potential emission locations
- Not all teams utilized catwalk to get close to vents
- Typically viewed against sky or tank as background

Next Steps in Analysis

- Multivariate regressions
- Adding meta data for leak location, viewing angle, and camera operator's experience



Thank You

Contact



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DISCLAIMER

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